

Plant Growing

Some Aspects of Growth and Development of Hybrid Citrus Seedlings Obtained through Distant Hybridization

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Abstract. The paper discusses some aspects of the growth and development of hybrid citrus seedlings obtained through distant hybridization. The use of biological methods in agronomic practices is an important factor for both confirming the advantages of organic agriculture production and developing methods to manage physiological processes as well as formulating indirect agronomic measures to enhance frost resistance. For this purpose, the bio-morphological features of hybrid citrus seedlings obtained through distant hybridization were analyzed under the climatic conditions of Imereti, taking into account the application of biological agro-technical methods. Promising, relatively frost-resistant forms were highlighted for establishing industrial plantations. The object of the research was experimental plants grown on the citrus demonstration plots of the Scientific Research Center for Agrarian Directions of Akaki Tsereteli State University. The use of biological methods of agrotechnical measures is essential, not only in confirming the advantages of organic agricultural production, but also in developing methods for managing physiological processes and implementing indirect agrotechnical measures to increase frost resistance. The use of the bioecological method applied by us (sowing green manures between the rows) somewhat protected the test plants from the adverse effects of the environment and did not significantly affect the intensity of their growth. Sowing green manures between rows also protected plants from the effects of high temperatures which during the test period was recorded at 40-42°C. © 2025 Bull. Georg. Natl. Acad. Sci.

Keywords: bio-ecological methods, hybrid citrus seedlings, indirect agronomic measures

Introduction

Georgia being a country with limited agricultural land, requires the rational use of its land resources. It is essential to develop farming systems that allow to obtain ecologically clean, competitive, and import-substituting agricultural products demanded

in the market. In this regard, it is important to cultivate crops that provide high-quality and ecologically clean products while being adapted to specific environmental conditions. Among the subtropical fruit crops distributed in Georgia, citrus fruits, particularly lemons and oranges, hold

significant importance from the perspective of public and agricultural use. However, it should be noted that the widespread distribution of these crops is somewhat limited due to the low frost resistance as a constraining factor. Currently, various systems of agro-technical measures for protecting plants from frost have been developed by researchers and practitioners from different countries. However, their implementation requires significant material and labor investments, making the production of these crops unprofitable in the end. Implementing protective measures against direct or indirect frosts in citrus fruits almost does not yield the expected positive results unless scientific research activities for enhancing frost resistance are conducted using selective methods simultaneously. One of such research works was conducted by us within the conditions of the Citrus Plant Selection and Genetics Research Laboratory at Akaki Tsereteli State University, where partial resolution of the mentioned problem was facilitated as part of a grant project funded by the Shota Rustaveli National Science Foundation from 2009 to 2012 [1, 2]. During distant hybridization, the maternal components selected for the cross combinations included lemon varieties: Villa-Franca, Meyer, Dioscuria, and the orange Washington-Navel, while the paternal components included spontaneous mutants of trifoliate #1 and #2, as well as complex hybrid “Kavkasia” derived from citrange of American origin (whose fruits do not contain substances that deteriorate flavor (poncirin, naringin, etc.)). Hybrid fruits were obtained according to cross combinations, and numerous hybrid seedlings were produced as a result of sowing the seeds isolated from them, which underwent genetic analysis based on phenotypic traits. Four groups of hybrid seedlings were distinguished: 1) traits extremely inclined towards the paternal plant, 2) traits extremely inclined towards the maternal plant, 3) intermediate forms with transitional traits, and 4) forms with entirely different traits [2, 3]. Subsequent bio-morpho-

logical investigations and the use of biological methods of agronomic measures on these citrus seedlings represent significant factors for confirming the advantages of organic agriculture production as well as developing indirect methods for managing physiological processes and enhancing frost resistance.

Research Object and Methodology

The implementation of the project titled “Application of Bio-Ecological Methods in Hybrid Citrus Gardens and Selection of Promising Forms” started in 2017 on the experimental plants laid out in the demonstration plots of the citrus plants at the Akaki Tsereteli State University.

The essence of the project lies in studying the bio-morphological characteristics of hybrid citrus seedlings obtained through distant hybridization under the environmental conditions of Imereti, utilizing biological methods of agronomy, selecting promising, relatively frost-resistant forms from them, and developing technology for growing seedlings for industrial plantations. The implementation of the planned objectives of the project began in March 2017, specifically from March 20 to March 30, when mass selection of hybrid seedlings obtained through the grant project was conducted and these seedlings were transferred to open ground.

Results and Discussion

The plants in the collection plots were divided into three variants:

The first variant – we gave it a controlling purpose, where no cover crops, mulching, and soil bio-preparations were used. We normally carry out all the agronomic activities that are accepted when establishing young citrus orchards (soil loosening, irrigation, application of nitrogenous and complex fertilizers);

In the second variant, on April 6 of this year, soybeans were sown as a green manure cover crop,

which we incorporated into the soil at a depth of 15-20 cm on July 10-11 during the flowering phase;

In the third variant, an organic fertilizer was applied in liquid form to the plants. This helps to improve soil structure, aeration, water permeability, retain minerals, propagate the microflora the balance of nutrients in the plant.

During the research process, regular measures were carried out against citrus pests and diseases as well as maintenance work – weeding soybeans between rows, processing inter-row spaces, loosening the soil around seedlings, irrigation, formative pruning; also, observations and recordings of bio-morphological characteristics and phenological phases of the experimental plants were conducted according to each variant.

The height of the plant trunks, the diameter of the canopies, the beginning and end of I and II growth were measured according to the variants. The results of these observations are presented in the Table.

As can be seen from the data in the Table, the seedlings with the following combinations stand out for their intense growth: Lemon Meyer X Ichangensis complex hybrid “Caucasia”; Lemon Dioscuria X Trifoliate mutant #2; Orange Washington Navel X Trifoliate mutant #2; Lemon Willifrank X Trifoliate mutant #1, these seedlings represent forms leaning towards the mother plant in terms of phenotypic traits, which in turn is very important and interesting for the continuation of further selection and agronomic work. In August of this year, extremely high temperatures of 40-42°C were recorded according to the meteorological station data, but the use of the bio-ecological method we applied (sowing cover crops in the rows) partially protected these plants from unfavorable environmental impacts and did not significantly affect the intensity of their growth waves.

Table. The results of the research on the characteristics of hybrid citrus seedlings growth

Hybrid plant combinations	Trunk height	Crown diameter	I growth		II growth	
			Beginning	End	Beginning	End
Lemon Meyer X Trifoliate mutant #1	1.4	1.8	30.03	10.06	5.08	8.11
Lemon Meyer X Trifoliate mutant #2	1.32	1.8	27.03	8.06	3.08	5.11
Lemon Meyer X Ichangensis complex hybrid “Caucasia”	1.5	2.2	28.03	8.06	5.08	5.11
Lemon Willifrank X Trifoliate mutant #1	1.28	1.4	25.03	5.06	4.08	3.11
Lemon Willifrank X Trifoliate mutant #2	1.45	1.5	31.03	12.06	7.08	10.11
Lemon Willifrank X Ichangensis complex hybrid “Caucasia”	1.32	1.4	28.03	9.06	4.08	6.11
Lemon Dioscuria X Trifoliate Mutant #1	1.35	1.4	30.03	10.06	5.08	7. 11
Lemon Dioscuria X Trifoliate mutant #2	1.55	1.8	25.03	5.06	3.08	4. 11
Lemon Dioscuria X Ichangensis complex hybrid “Caucasia”	1.3	1.4	27.03	8.06	5.08	5. 11
Orange Washington-Navel X Trifoliate #1	1.4	1.7	27.03	9.06	4.08	6. 11
Orange Washington-Navel X Trifoliate #2	1.42	1.8	25.03	5.06	2.08	3. 11
Oragne Washington-Navel X Ichangensis complex hybrid “Caucasia”	1.35	1.5	30.03	8.06	3.08	5. 11

Conclusion

Thus, the use of biological methods of agronomic measures is an important factor, both in terms of confirming the advantages of organic farming production and developing methods for managing physiological processes and creating indirect agronomic measures for increasing frost resistance.

Based on biometric data obtained from the agronomic and agrobiological measures carried out on hybrid seedlings, we can conclude that the sowing of cover crops – representatives of the legume family (soybeans) in the inter-rows positively affects not only soil structure but also the physiological processes occurring in the plant.

მემცენარეობა

შორეული ჰიბრიდიზაციის შედეგად მიღებული ციტრუსოვანთა ჰიბრიდული თესლნერგების ზრდა-განვითარების ზოგიერთი ასპექტი

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ნაშრომში განხილულია შორეული ჰიბრიდიზაციის შედეგად მიღებული ციტრუსოვანთა ჰიბრიდული თესლნერგების ზრდა-განვითარების ზოგიერთი ასპექტი. აგროტექნიკურ ღონისძიებათა ბიოლოგიური მეთოდების გამოყენება წარმოადგენს მნიშვნელოვან ფაქტორს როგორც ორგანული სოფლის მეურნეობის წარმოების უპირატესობის დადასტურების მხრივ, ასევე ფიზიოლოგიური პროცესების მართვის მეთოდების შემუშავებისა და ყინვაგამძლეობის ამაღლების არაპირდაპირი აგროტექნიკური ღონისძიებების შემუშავების თვალსაზრისით. ამ მიზნით შესწავლილ იქნა, იმერეთის პირობებში შორეული ჰიბრიდიზაციის შედეგად მიღებული, ციტრუსოვანთა ჰიბრიდული თესლნერგების ბიო-მორფოლოგიური თავისებურებები აგროტექნიკის ბიოლოგიური მეთოდების გამოყენების ფონზე. შეირჩა პერსპექტიული, შედარებით ყინვაგამძლე ფორმები სამრეწველო პლანტაციების გასაშენებლად. კვლევის ობიექტს წარმოადგენდა აკაკი წერეთლის სახელმწიფო უნივერსიტეტის აგრარული მიმართულებების სამეცნიერო კვლევითი ცენტრის ციტრუსოვან სადემონსტრაციო ნაკვეთებზე განთავსებული ექსპერიმენტული მცენარეები. აგროტექნიკური ღონისძიებების ბიოლოგიური მეთოდების გამოყენება მნიშვნელოვანი ფაქტორია როგორც ორგანული სასოფლო-სამეურნეო წარმოების უპირატესობების დადასტურების, ასევე ფიზიოლოგიური პროცესების მართვის მეთოდების შემუშავებისა და ყინვაგამძლეობის გაზრდის არაპირდაპირი აგროტექნიკური ღონისძიებების

შემუშავების თვალსაზრისით. ჩვენ მიერ ბიოეკოლოგიური მეთოდის გამოყენებამ (მწკრივებს შორის მწვანე სასუქების დათესვა) გარკვეულწილად დაიცვა საცდელი მცენარეები გარემოს მავნე ზემოქმედებისგან და მნიშვნელოვნად არ იმოქმედა მათი ზრდის ინტენსივობაზე. მწკრივებს შორის მწვანე სასუქის დათესვამ ასევე დაიცვა მცენარეები მაღალი ტემპერატურის ზემოქმედებისგან. კვლევის პერიოდში დაფიქსირდა მაღალი ტემპერატურა – 40-42°C.

REFERENCES

1. Getsadze G., Sanikidze J., Kopaliani R., Jobava T., Kobalia V., Kipiani N. (2013) The problem of frost resistance of citrus and its solution using the method of distant hybridization. *Scientific-Practical Conference "Commercialization of Research Results of Agricultural Scientists"*, p. 301-306. Kutaisi (in Georgian).
2. Getsadze G., Sanikidze J., Kopaliani R., Kobalia V., Kipiani N. (2013) Methodology for increasing the frost resistance of citrus using distant hybridization. *Publishing House "Mze"*, p. 1-14. Kutaisi (in Georgian).
3. Kipiani N. (2013) Results of hybridological work conducted along the lines of distant hybridization in citrus. *International Scientific-Practical Conference "Innovative Technologies for the Sustainable and Safe Development of the Agricultural Sector"*, p.214-216. Tbilisi (in Georgian).

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